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Effect of gamma irradiation fortified with edible coatings on post-harvest quality of litchi cv. Rose Scented

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Abstract
The global demand for fresh and high-quality fruits is on the rise, presenting a challenge for growers and suppliers to minimize post-harvest losses and extend the shelf life of fruits. The perishable nature of litchi makes marketing and transportation extremely difficult. This study aimed to preserve the post-harvest quality of litchi cv. Rose Scented by using a gamma irradiation approach with edible coatings. The physical and biochemical parameters were analyzed, and it was found that after 20 days of the storage period, 1.0 kGy treatment was most effective in reducing loss in weight and maintaining the fruit diameter, and was also beneficial for biochemical parameters like reducing sugar and taste of the fruits.

Keywords: Irradiation, *Litchi chinensis* Sonn, edible coatings, post-harvest, quality

Introduction
Litchi (*Litchi chinensis* Sonn.) is the most important member of the Sapindaceae family. Over the past three decades, the litchi sector in India has witnessed noteworthy growth in both production and cultivated land (Sahni *et al*., 2020) [17]. The inherent challenge of short shelf life, spanning 2 to 4 days, shows when untreated litchi fruits are subjected to room temperature conditions. This transience contributes to substantial losses and wastage during peak market influx, as highlighted by Jiang and Jiang (2005) [22]. Against this backdrop, a confluence of research endeavors and commercial pressures is navigating the quest for innovative strategies aimed at preserving fruit quality and shelf life (Mahajan *et al*., 2018) [11]. A time-tested technique gaining traction is irradiation, which has been harnessed extensively to bestow extended shelf life and enduring quality upon fruits during storage, as expounded by Sousa-Gallagher *et al*. (2016) [23]. Within the food industry, the burgeoning potential of radioactivity in food processing and preservation is evidenced, a trend elucidated by Lima *et al*. (2018) [21]. The consensus of the (Food and Agriculture Organization) FAO, (International Atomic Energy Agency) IAEA, and (World Health Organization) WHO, joint expert committee endorses the admissible dosage of up to 10 kGy in food processing (Khalil *et al*. (2009) [10]. The substitution of a natural waxy safeguard, akin to chitosan and *Aloe vera* gel, with a thin layer of edible material assumes a fundamental role in augmenting fruit longevity. Chitosan, an adapted natural carbohydrate polymer derived from chitin, a bioactive compound culled from diverse sources encompassing crustaceans, fungi, insects, and certain algae (Shiekh *et al*., 2013) [20]. *Aloe vera*, known as the "medicinal plant," garners renowned for its multifarious curative properties. The annals of history substantiate its omnipresence in written records, underscoring its status as a versatile herbal stalwart, as documented by Eshun and He (2005) [6]. The implementation of coatings conveys the potential to mitigate physiological weight loss, spoilage, and ripening processes while upholding attributes that emblemize high quality, such as firmness, soluble solids, and titratable acidity, as postulated by Bola *et al*. (2017) [5].

Methods and Materials
The research was carried out at the Horticultural Research Centre and the Department of Horticulture, Govind Ballabh Pant University of Agriculture and Technology, situated in Pantnagar, U.S. Nagar, Uttarakhand. This location resides within the Tarai region of the Himalayas, characterized by a humid subtropical climate. The implementation of gamma radiation was executed on individual samples, each weighing 2 kg.

These samples underwent varying doses of radiation, specifically 0.8 kGy, 1.0 kGy, and 1.2 kGy, within the controlled environment of the Radiations and Isotopic Tracer Laboratory (RITL) at the College of Basic Science and Humanities in Pantnagar. All 19 treatments one is untreated fruits (T1- control), three treatments of gamma radiation (T2- 0.8 kGy, T3- 1.0 kGy and T4- 1.2 kGy) and 6 treatments with combination chitosan (T5-0.8 kGy + 1.0% chitosan, T6-1.0 kGy + 1.0% chitosan, T7- 1.0 kGy + 1.0% chitosan, T8-0.8 kGy + 1.5% chitosan, T9-1.0 kGy + 1.5% chitosan, T10- 1.0 kGy + 1.5% chitosan) and with *Aloe vera* gel (T11- 0.8 kGy + 10% *Aloe vera* gel, T12- 1.0 kGy + 10% *Aloe vera* gel, T13- 1.2 kGy + 10% *Aloe vera* gel, T14- 0.8 kGy + 25% *Aloe vera* gel, T15- 1.0 kGy + 25% *Aloe vera* gel, T16- 1.2 kGy + 25% *Aloe vera* gel, T17- 0.8 kGy + 50% *Aloe vera* gel, T18- 1.0 kGy + 50% *Aloe vera* gel, T19 - 1.2 kGy + 10% *Aloe vera* gel) all samples were stored at a low temperature of 2 °C in perforated zipper plastic bags and evaluated at alternate intervals of four days until 20 days of storage.

Aloe vera gel coating preparation
The filtration technique is employed as a means to extract *Aloe vera* gel from the leaves. In order to take the same level of maturity, size, color, and freshness, a careful leaf selection process is undertaken, followed by a complete washing using tap water, followed by a rinse using distilled water. After blending procedures to be extracted from the *Aloe vera* leaves. The filtration process is aimed at eliminating any residual fibers, consequently yielding a pristine composition of 100% pure *Aloe vera* gel. To fine-tune the pH level, 4.5 grams of citric acid is added to pH reduction of 4. In order to ensure microbiological safety and product stability, the prepared Aloe gel undergoes pasteurization, a process involving exposure to a temperature of 70 °C for a duration of 45 minutes (Marpudi *et al*., 2011) [13].

Chitosan coating preparation
The formulation of the coating solution involved the dissolution of 10 and 15 g of chitosan powder in 900 milliliters of distilled water. Subsequently, the incorporation of 50 mL of glacial acetic acid facilitated the chitosan's dissolution, concentrations of 1.0% and 1.5% chitosan solutions within a total volume of 1 liter. The pH of these solutions was carefully regulated to 5.0 by utilizing 0.1M Farahi NaOH for precise adjustment.

Fruit diameter (cm)
The fruit width was measured from the ten fruits/replication was recorded with the help of Digital Vernier’s Caliper and calculated average fruit width.

Fruit weight (g)
Each treatment comprising 10 fruits was taken randomly and weighed on electronic balance at different time intervals. The average weight of the fruit was obtained and expressed in grams.

Reducing sugars (%)
The determination of reducing sugars followed the standard methodology outlined by the Association of Official Agricultural Chemists (AOAC, 1990) [1]. 10 milliliters of fresh juice were taken and diluted to 100 mL with distilled water. Lead acetate was added to the solution to precipitate any superfluous materials, and excess lead was then removed using potassium oxalate. The resulting solution was filtered using filter paper, generating an aliquot for further analysis. Subsequently, the obtained filtrate was transferred to a burette for titration. In a conical flask, Fehling solutions A and B (each 5 mL) were combined and heated on a hot plate. The above-neutralized solution was titrated against the Fehling solutions, with methylene blue serving as the indicator. The titration process continued until the appearance of a brick-red color in the solution, which served as the endpoint reading.

$$\text{Reducing sugars (\%)} = \frac{\text{Fehlings factor (0.05)} \times \text{Dilution made}}{\text{Titre value} \times \text{Weight of sample}} \text{ x } 100$$

Organoleptic evaluation: Litchi samples were chosen at random for sensory evaluation solely based on their outward acceptability. Fungus- and rotten-filled samples were discarded. A panel of ten horticulturists, and food technologists, evaluated the color appearance of litchi. The scoring was done using a 9-point hedonic scale, with 0-2 being very poor, 2-4 being poor, 4-6 being fair, 6-8 being good, and 8-9 being very good.

Results and Discussion
Effect on fruit diameter
The present investigation given valuable insights into the interplay between gamma irradiation and a combined approach with edible coatings concerning the change in litchi fruit diameter under refrigerated storage conditions. The data, presented in Table 1, explain that irradiation fortified with edible coatings method exerts a significant influence on litchi fruit diameter in comparison to T_1 (control). Throughout the study, all treatments exhibited significant results in fruit diameter, with the exception of the control (T_1), which displayed the least fruit diameter of 22.93 mm over the 20-day storage period. Conversely, the remaining treatments demonstrated favorable outcomes. Among these, treatments T_3D_6 (1.0 kGy 20th day of storage) recorded the highest retention of fruit diameter at 28.62mm, followed by $T_{12}D_6$ (1.0 kGy + 10% *Aloe vera* gel with 20th day of storage) i.e., 27.65mm after 20 days of storage. Results distinctly indicate a continuous decline in fruit diameter with the passage of time. This decrease can be attributed to the loss of moisture, which consequently results in a reduction in fruit size. The study's findings support the hypothesis that treatments exert a significant impact on litchi fruits, effectively reducing moisture loss compared to untreated fruits. The application of irradiation, along with the edible coating, creates a semi-permeable film that regulates gaseous exchange and reduces the transpiration rate. This regulation is determined by the gradient of water vapor pressure between the fruit and the surrounding air, as reported by Bautista-Banos *et al*. (2006) [4]. Majeed *et al*. (2014) [12] conducted research that highlighted the significant influence of radiation dosages on fruit diameter. Farahi (2015) [7] revealed that the application of *Aloe vera* gel showed less reduction in weight loss percentage compared to the control fruit.

Table 1: Effect of gamma irradiation fortified with edible coatings on diameter of litchi cv. Rose Scented

Year	Pooled data (2022 and 2023)					
Treatments	Storage intervals (days)					
	D_1 (0)	D_2 (4)	D_3 (8)	D_4 (12)	D_5 (16)	D_6 (20)
T1- Control	32.10^{a}	31.93^{a}	30.58^{c}	28.42^{g}	24.41^{h}	22.93^{k}
T2- 0.8 kGy	32.09^{a}	32.09^{a}	31.60^{ab}	31.03^{b}	29.64^{c}	27.43^{bc}
T3- 1.0 kGy	32.10^{a}	32.10^{a}	31.87^{a}	31.51^{a}	30.58^{a}	28.62^{a}
T4- 1.2 kGy	32.10^{a}	32.10^{a}	31.60^{ab}	31.01^{bc}	29.66^{c}	27.28^{cd}
T5- 0.8 kGy + 1.0% chitosan	32.01^{a}	32.01^{a}	31.55^{ab}	30.78^{bcd}	29.41^{cde}	27.16^{cdef}
T6- 1.0 kGy + 1.0% chitosan	32.08^{a}	32.08^{a}	31.54^{ab}	30.79^{bcd}	29.23^{def}	26.90^{efg}
T7- 1.2 kGy + 1.0% chitosan	32.14^{a}	32.14^{a}	31.55^{ab}	30.84^{bcd}	29.20^{def}	26.85^{fgh}
T8- 0.8 kGy + 1.5% chitosan	32.08^{a}	32.08^{a}	31.52^{ab}	30.67^{cde}	29.15^{ef}	26.53^{hi}
T9- 1.0 kGy + 1.5% chitosan	32.02^{a}	32.02^{a}	31.41^{b}	30.37^{ef}	28.58^{g}	26.24^{i}
T10- 1.2 kGy + 1.5% chitosan	32.03^{a}	32.03^{a}	31.34^{b}	30.24^{f}	28.37^{g}	25.87^{j}
T11- 0.8 kGy +10% *Aloe vera* gel	32.06^{a}	32.06^{a}	31.53^{ab}	30.86^{bcd}	29.40^{cde}	26.94^{defg}
T12- 1.0 kGy +10% *Aloe vera* gel	32.02^{a}	32.02^{a}	31.65^{ab}	31.09^{b}	30.08^{b}	27.65^{b}
T13- 1.2 kGy +10% *Aloe vera* gel	32.07^{a}	32.07^{a}	31.56^{ab}	30.89^{bcd}	29.45^{cde}	26.96^{defg}
T14- 0.8 kGy +25% *Aloe vera* gel	32.08^{a}	32.08^{a}	31.58^{ab}	30.92^{bcd}	29.50^{cd}	27.00^{defg}
T15- 1.0 kGy +25% *Aloe vera* gel	32.08^{a}	31.94^{a}	31.57^{ab}	30.95^{bc}	29.58^{c}	27.20^{cde}
T16- 1.2 kGy +25% *Aloe vera* gel	32.05^{a}	32.05^{a}	31.53^{ab}	30.85^{bcd}	29.37^{cde}	26.83^{fgh}
T17- 0.8 kGy +50% *Aloe vera* gel	32.08^{a}	32.08^{a}	31.55^{ab}	30.80^{bcd}	29.32^{cde}	26.95^{defg}
T18- 1.0 kGy +50% *Aloe vera* gel	32.04^{a}	32.04^{a}	31.42^{b}	30.66^{cde}	29.14^{ef}	26.75^{gh}
T19- 1.2 kGy +50% *Aloe vera* gel	32.04^{a}	32.04^{a}	31.41^{b}	30.57^{de}	28.93^{f}	26.43^{i}

*same letter in a column showing no significant difference

Effect on fruit weight (g)

The data presented in Table 2, evident that the notable influence of irradiation and the application of edible coatings on the weight of litchi cv. Rose Scented. The effect of treatments over the storage period was found significant. The table clearly demonstrates that untreated fruits experienced the maximum loss in fruit weight after 8 and 12 days of storage. On the other hand, the treated fruits exhibited favorable performance with minimal significant differences observed. After 16 and 20 days of storage, untreated fruits displayed nearly double the loss in fruit weight compared to the treated fruits. After 20 days of storage among all the treatments, T_1D_6 demonstrated the highest loss in fruit weight (15.44g), followed by $T_{10}D_6$ (1.2 kGy + 1.5% chitosan with 20th of storage) i.e., 17.86g. Conversely, the other treatments and storage durations exhibited a significant influence on fruit weight. Among these treatments, the minimum loss in fruit weight (19.99g) was observed in T_3D_6 (1.0 kGy with 20th of storage), which was statistically *at par* with $T_{12}D_6$ (1.0 kGy +10% *Aloe vera* gel with 20th of storage) at 17.93g after a 20-day storage interval. Notably, the irradiation and *Aloe vera* gel-based coated fruits exhibited superior performance compared to chitosan-coated and untreated fruits. The preservation of higher fruit weight observed in the treated fruits can be attributed to the effective reduction in moisture loss, thereby maintaining turgidity and superior fruit weight compared to the control fruits, which experienced higher levels of moisture loss (Baraiya *et al.*, 2014) [3]. The treatments, excluding the control, successfully established a physical barrier that minimized moisture loss, resulting in reduced weight loss during evaluation. The formation of a protective film on the fruit's skin acted as an additional barrier against moisture loss, as evidenced in this study (Kamboj and Kaur, 2018) [9]. Sau *et al.* (2018) [18] support that gamma radiation treatment can effectively mitigate fruit weight losses. Abraham and Banerjee (2018) [2] reported that edible coatings played a vital role in minimizing weight loss in guava fruits while preserving their overall freshness and quality.

Table 2: Effect of gamma irradiation fortified with edible coatings on fruit weight of litchi cv. Rose Scented

Year	Pooled data (2022 and 2023)					
Treatments	Storage intervals (days)					
	D_1 (0)	D_2 (4)	D_3 (8)	D_4 (12)	D_5 (16)	D_6 (20)
T1- Control	23.09^{a}	22.86^{a}	22.20^{c}	20.37^{e}	17.64^{i}	15.44^{i}
T2- 0.8 kGy	23.14^{a}	23.14^{a}	22.81^{ab}	22.14^{bcd}	21.03^{bc}	18.94^{bc}
T3- 1.0 kGy	23.15^{a}	23.15^{a}	22.98^{a}	22.56^{a}	21.74^{a}	19.99^{a}
T4- 1.2 kGy	23.18^{a}	23.18^{a}	22.89^{ab}	22.32^{ab}	20.67^{de}	18.49^{de}
T5- 0.8 kGy + 1.0% chitosan	23.08^{a}	23.08^{a}	22.74^{ab}	22.07^{bcd}	20.64^{e}	17.99^{fgh}
T6- 1.0 kGy + 1.0% chitosan	22.97^{a}	22.97^{a}	22.57^{bc}	21.82^{d}	20.25^{g}	18.10^{fgh}
T7- 1.2 kGy + 1.0% chitosan	22.99^{a}	22.99^{a}	22.61^{ab}	21.90^{cd}	20.28^{fg}	18.10^{fgh}
T8- 0.8 kGy + 1.5% chitosan	23.06^{a}	23.06^{a}	22.65^{ab}	21.88^{cd}	20.28^{fg}	18.08^{fgh}
T9- 1.0 kGy + 1.5% chitosan	23.05^{a}	23.05^{a}	22.59^{bc}	21.87^{cd}	19.89^{h}	17.93^{gh}
T10- 1.2 kGy + 1.5% chitosan	23.16^{a}	23.16^{a}	22.72^{ab}	21.93^{cd}	19.86^{h}	17.86^{h}
T11- 0.8 kGy +10% *Aloe vera* gel	23.19^{a}	23.19^{a}	22.85^{ab}	22.16^{bcd}	21.01^{bcd}	19.00^{b}
T12- 1.0 kGy +10% *Aloe vera* gel	23.07^{a}	23.07^{a}	22.82^{ab}	22.35^{ab}	21.32^{b}	19.73^{a}
T13- 1.2 kGy +10% *Aloe vera* gel	23.15^{a}	23.15^{a}	22.84^{ab}	22.09^{bcd}	21.05^{bc}	18.80^{bcd}
T14- 0.8 kGy +25% *Aloe vera* gel	23.11^{a}	23.11^{a}	22.74^{ab}	22.10^{bcd}	20.78^{cde}	18.30^{ef}

T15- 1.0 kGy +25% *Aloe vera* gel	23.11^{a}	23.11^{a}	22.75^{ab}	22.21^{bc}	21.14^{bc}	18.65^{cd}
T16- 1.2 kGy +25% *Aloe vera* gel	23.08^{a}	23.08^{a}	22.76^{ab}	22.10^{bcd}	20.85^{cde}	18.47^{de}
T17- 0.8 kGy +50% *Aloe vera* gel	23.16^{a}	23.16^{a}	22.78^{ab}	22.20^{bc}	21.09^{bc}	18.50^{de}
T18- 1.0 kGy +50% *Aloe vera* gel	23.06^{a}	23.06^{a}	22.73^{ab}	22.08^{bcd}	20.68^{de}	18.51^{de}
T19- 1.2 kGy +50% *Aloe vera* gel	23.12^{a}	23.12^{a}	22.74^{ab}	21.99^{bcd}	20.60^{ef}	18.27^{efg}

*same letter in a column showing no significant difference

Effect on reducing sugars (%)

The impact of various treatments on the reducing sugar content in litchi fruits was found to be significant which was presented in Table 3. The interaction effect of treatments over the storage period was found significant. The data clearly demonstrates a consistent trend of increasing sugar levels from the initial day of storage up to the 20th day. Notably, on the 4th day of storage, no significant differences were observed among the different treatments. However, the maximum reducing sugar content of 13.48% was recorded in T_3D_6 (1.0 kGy with 20 days of storage), which was statistically *at par* with $T_{12}D_6$ (1.0 kGy + 10% *Aloe vera* gel with 20 days of storage) at 13.28% as well. Furthermore, the results indicate that the uncoated fruits T_1D_3 (control with 8^{th} days of storage) exhibited a rapid increase in reducing sugar content, reaching 11.06% on the 8th day of storage, followed by a continuous decrease to 9.27% on the 20th day (T_1D_6). These findings provide clear evidence of the effect of different treatments on the reducing sugar content of litchi fruits during the storage period. This rise in reducing sugars can be attributed to accelerated ripening and starch dissolution. Based on these findings, it can be concluded that both irradiated treatments and integrated irradiation techniques have a significant impact on preserving the overall sugar content in litchi fruits throughout an extended storage period. Previous studies by Pandey *et al*. (2013) [16] have also shown a significant effect on the reducing sugar content of irradiated litchi fruits on the 19th day of storage. Additionally, Padmaja *et al*. (2015) [15] demonstrated that treatments utilizing *Aloe vera* gel coating were the most effective in maintaining the fruits' biochemical characteristics. Sharmin *et al*. (2015) [19] observed noteworthy changes in the sugar content of papaya fruits during the storage period, specifically observing a substantial increase.

Table 3: Effect of gamma irradiation fortified with edible coatings on reducing sugars of litchi cv. Rose Scented

Year	**Pooled data (2022 and 2023)**					
Treatments	**Storage intervals (days)**					
	D_1 (0)	**D_2 (4)**	**D_3 (8)**	**D_4 (12)**	**D_5 (16)**	**D_6 (20)**
T1- Control	8.75^{a*}	10.17^{a}	11.06^{a}	10.12^{f}	9.69^{g}	9.27^{g}
T2- 0.8 kGy	8.75^{a}	9.57^{b}	10.12^{bc}	10.93^{cde}	11.74^{bcde}	12.43^{bc}
T3- 1.0 kGy	8.75^{a}	9.42^{b}	9.77^{c}	11.74^{a}	12.49^{a}	13.48^{a}
T4- 1.2 kGy	8.75^{a}	9.79^{ab}	10.32^{b}	10.87^{cde}	11.48^{cdef}	11.99^{cde}
T5- 0.8 kGy + 1.0% chitosan	8.75^{a}	9.78^{ab}	10.24^{bc}	10.87^{cde}	11.40^{ef}	12.04^{bcde}
T6- 1.0 kGy + 1.0% chitosan	8.75^{a}	9.80^{ab}	10.40^{b}	11.01^{cde}	11.74^{bcde}	12.19^{bcd}
T7- 1.2 kGy + 1.0% chitosan	8.75^{a}	9.74^{ab}	10.59^{b}	10.97^{cde}	11.59^{cdef}	12.05^{bcde}
T8- 0.8 kGy + 1.5% chitosan	8.75^{a}	9.92^{ab}	10.31^{bc}	11.02^{cde}	11.63^{cdef}	12.02^{bcde}
T9- 1.0 kGy + 1.5% chitosan	8.75^{a}	9.91^{ab}	10.56^{b}	10.68^{de}	11.25^{ef}	11.72^{def}
T10- 1.2 kGy + 1.5% chitosan	8.75^{a}	9.75^{ab}	10.58^{b}	10.52^{ef}	11.16^{f}	11.47^{f}
T11- 0.8 kGy +10% *Aloe vera* gel	8.75^{a}	9.79^{ab}	10.12^{bc}	10.68^{de}	11.32^{ef}	12.14^{bcd}
T12- 1.0 kGy +10% *Aloe vera* gel	8.75^{a}	9.76^{ab}	10.05^{bc}	11.60^{ab}	12.16^{ab}	13.28^{a}
T13- 1.2 kGy +10% *Aloe vera* gel	8.75^{a}	9.59^{b}	10.39^{b}	11.08^{cd}	11.69^{bcde}	12.53^{b}
T14- 0.8 kGy +25% *Aloe vera* gel	8.75^{a}	9.76^{ab}	10.54^{b}	11.27^{abc}	11.42^{def}	11.58^{ef}
T15- 1.0 kGy +25% *Aloe vera* gel	8.75^{a}	9.74^{ab}	10.14^{bc}	11.32^{abc}	11.70^{bcde}	12.16^{bcd}
T16- 1.2 kGy +25% *Aloe vera* gel	8.75^{a}	9.84^{ab}	10.35^{b}	11.22^{bc}	11.71^{bcde}	12.11^{bcd}
T17- 0.8 kGy +50% *Aloe vera* gel	8.75^{a}	9.82^{ab}	10.44^{b}	11.31^{abc}	11.94^{bcd}	11.88^{def}
T18- 1.0 kGy +50% *Aloe vera* gel	8.75^{a}	9.86^{ab}	10.09^{bc}	11.33^{abc}	11.97^{bc}	12.09^{bcde}
T19- 1.2 kGy +50% *Aloe vera* gel	8.75^{a}	9.78^{ab}	10.31^{bc}	11.25^{abc}	11.60^{cdef}	12.05^{bcde}

*same letter in a column showing no significant difference

Effect on taste of litchi fruit

The data presented in Table 4, offers valuable insights into the sensory evaluation of taste using a 9-point hedonic scale during fruit storage and found a significant effect of treatments on the taste of fruits. The interaction effect of treatments over the storage period was found significant. Throughout the year 2022, it was evident that all treatments exerted a significant influence. Over the course of storage, the taste scores for the fruits remained consistently favorable, ranging from extremely like to moderately like. In the year 2022, treatment T_3D_6 (1.0 kGy with 20^{th} of storage) displayed the highest taste score of 5.00, statistically *at par* to $T_{12}D_6$ (1.0 kGy + 10% *Aloe vera* gel with 20^{th} of storage). In contrast, the control T_1D_4 (control with 12^{th} day of storage) exhibited the lowest taste score of 2.00 after 12 days of storage, rendering the fruits unsuitable for human consumption. Taste perception in fruits is influenced by the presence of various soluble constituents, such as sugars, salts, and titratable acidity, as well as a heterogeneous collection of bitter principles, including alkaloids. The findings also indicated that fruit taste decreased significantly with the advancement of the storage period, likely attributed to fluctuations in pH and the TSS: acid ratio. These observations underscore the importance of carefully managing storage conditions and employing suitable treatments to preserve the desirable taste of litchi fruits and enhance their overall sensory appeal to consumers. Naresh *et al*. (2015) [14] irradiation doses maintain the sensory quality during storage and even enhance the sensory properties compared to the control samples. Hazare *et al*. (2010) [8] irradiated litchi fruits without compromising their sensory and maintenance of fruit quality during storage.

Table 4: Effect of gamma irradiation fortified with edible coatings on the taste of litchi cv. Rose Scented

Year	Pooled data (2022 and 2023)					
Treatments	Storage intervals (days)					
	D_1 (0)	D_2 (4)	D_3 (8)	D_4 (12)	D_5 (16)	D_6 (20)
T1- Control	9.00^{a*}	6.33^{c}	4.33^{e}	2.00^{f}	1.00^{d}	1.00^{f}
T2- 0.8 kGy	9.00^{a}	6.67^{c}	5.67^{bcd}	5.00^{bcde}	4.17^{bc}	3.50^{cde}
T3- 1.0 kGy	9.00^{a}	7.67^{a}	6.83^{a}	5.67^{ab}	5.33^{a}	5.00^{a}
T4- 1.2 kGy	9.00^{a}	6.67^{c}	6.17^{abc}	5.00^{bcde}	4.00^{c}	3.33^{cde}
T5- 0.8 kGy + 1.0% chitosan	9.00^{a}	7.00^{abc}	6.33^{abc}	5.17^{bcde}	4.50^{bc}	3.50^{cde}
T6- 1.0 kGy + 1.0% chitosan	9.00^{a}	6.67^{c}	5.83^{bcd}	4.50^{de}	4.50^{bc}	3.17^{cde}
T7- 1.2 kGy + 1.0% chitosan	9.00^{a}	6.83$^{a\ c}$	5.67^{bcd}	4.50^{de}	4.17^{bc}	3.00^{de}
T8- 0.8 kGy + 1.5% chitosan	9.00^{a}	6.50^{c}	5.00^{de}	4.33^{e}	4.17^{bc}	3.33^{cde}
T9- 1.0 kGy + 1.5% chitosan	9.00^{a}	6.33^{c}	5.17^{de}	4.50^{de}	4.17^{bc}	2.83^{e}
T10- 1.2 kGy + 1.5% chitosan	9.00^{a}	6.33^{c}	5.67^{bcd}	4.50^{de}	3.83^{c}	2.83^{e}
T11- 0.8 kGy +10% *Aloe vera* gel	9.00^{a}	6.83^{ac}	6.17^{abc}	4.83^{bcde}	4.50^{bc}	4.00^{bc}
T12- 1.0 kGy +10% *Aloe vera* gel	9.00^{a}	7.67^{ab}	6.50^{ab}	6.00^{a}	5.00^{ab}	4.67^{ab}
T13- 1.2 kGy +10% *Aloe vera* gel	9.00^{a}	7.00^{abc}	5.67^{bcd}	5.17^{bcde}	4.17^{bc}	4.00^{bc}
T14- 0.8 kGy +25% *Aloe vera* gel	9.00^{a}	7.00^{abc}	6.17^{abc}	5.33^{abcd}	4.67^{abc}	3.83^{cd}
T15- 1.0 kGy +25% *Aloe vera* gel	9.00^{a}	6.50^{c}	5.83^{bcd}	5.50^{abc}	4.17^{bc}	4.00^{bc}
T16- 1.2 kGy +25% *Aloe vera* gel	9.00^{a}	6.83$^{a\ c}$	5.67^{bcd}	5.00^{bcde}	4.50^{bc}	3.33^{cde}
T17- 0.8 kGy +50% *Aloe vera* gel	9.00^{a}	6.50^{c}	5.67^{bcd}	4.67^{cde}	4.33^{bc}	3.50^{cde}
T18- 1.0 kGy +50% *Aloe vera* gel	9.00^{a}	6.67^{c}	5.50^{cd}	5.00^{bcde}	4.33^{bc}	3.67^{cde}
T19- 1.2 kGy +50% *Aloe vera* gel	9.00^{a}	6.50^{c}	5.67^{bcd}	4.67^{cde}	4.17^{bc}	3.50^{cde}

*same letter in a column showing no significant difference

Conclusion

The present investigation concludes that the litchi cv. Rose Scented when subjected to a 1.0 kGy treatment, exhibited the highest level of effectiveness in maintaining postharvest quality parameters. Notably, this treatment resulted in an extension of shelf life by 3 to 4 times more than, in comparison to untreated control fruits. This discovery bears significant implications for advancing the preservation and market readiness of litchi fruits when stored under refrigerated conditions.

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